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Intersectoral Migration of Agricultural Labor Force and Business Cycles in Developing Countries

发展中国家的农业劳动力转移和经济周期

Auswanderungen der landwirtschaftlichen Arbeitskraefte und Konjunkturen in den Entwicklungslaendern

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Intersectoral Migration of Agricultural Labor Force and Business Cycles in the Developing Countries

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Abstract

This paper establishes a framework to analyze short-run macroeconomic cycles with intersectoral migrations of agricultural labor in the developing economies. It first defines indicators to measure the migration and finds its cyclical fluctuations combined with business cycles. A model of the labor and commodity markets is set up to investigate equilibrium mechanisms of intersectoral migration as well as fluctuations and adjustments of price and migration in response to shocks. It shows flexible prices and wage rates with labor mobility can lead to a new equilibrium, but the economy may experience booms and slowdowns with return migrations of agricultural labor.

Keywords: Short-run macroeconomics of the developing countries; measures of agricultural labor migration; facts of agricultural labor migration; business cycles with agricultural labor migration; China

JEL Classification No.: E32, O11, O41

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Intersectoral Migration of Agricultural Labor Force and Business Cycles in Developing Countries

Labor migration from precapitalist agriculture into capitalist nonagriculture is a striking character of modern economic growth, which particularly manifests itself in the decline of the share of labor force engaged in agriculture. The long-run declining trend of the share is well known after Clark (1940) and Kuznets (1966) and studied by Lewis (1954), Jorgenson (1961), Ranis and Fei (1961) in development economics and recently by Matsuyama (1992), Kongsamut, Rebelo and Xie (2001), Gollin, Parente and Rogerson (2002), Ngai and Pissarides (2007) and many others under the keyword “structural change”. The short-run fluctuations of the share, however, have attracted little attention in development and macroeconomic researches.[1] In a popular textbook on development economics (Perkins, Radelet, Snodgrass, et al., 2001: 3-6), for example, the authors introduce the reader to the discipline with a narrative of a young Malaysian girl who went from a poor village to a urban factory for much more income and worked for several years, and came with her savings back to the village after a recession hit the manufacturing industry. For the authors the return to village is the happy destination of the girl and the end of the story, hence they do not deal with the migration in any forms further.[2] But most of migratory farmers prefer to remain in nonfarm employment. Indeed, the long-run trend of agricultural labor transferring into nonagriculture could not be understood without positive imaginations of nonfarm employments by the most of farmers. Why, however, must sometimes migratory “farmer-workers” be confronted with the return migration after several years’

[1] Academic efforts to combine business cycle with agriculture have a very long history. Cantillon (1755/1831), e.g., already points out the short-run fluctuations of food production and population growth, which was accepted by almost all classical economists (Hayek, 1931, XXVII). The most known effort was probably made by Jevons (1884) who argues that fluctuations in agricultural production may cause the business cycles. But the former is brought about by periodical explosions of the sunspots. In the United States, Sprague (1903), Andrew (1906) and Anderson (1927, 1931) find close combinations of business cycles with fluctuations in purchasing power of farmers in the United States, which, in turn, are dependent on harvests. To explain the economic crises in 1930s Keynes (1936: 205-206) determinately rejects this agricultural theory of business cycles. The theory has disappeared completely since then. Recently, however, there come new interests in it for understanding the business cycles in the pre-Great Depression era. See e.g., Miron (1986), Davis, Hanes and Rhode (2009). But this theoretical line does not address the role the intersectoral migration of agricultural labor may play in business cycles. One of the reasons for it can be that labor statistics of that period are not available to both the contemporary and today’s researchers. In another direction, Jerome (1926) explained the business cycles in the target countries have effects on international migration. Similar effects on internal migration, a substantial parts of which is migration between farm and nonfarm areas, are mentioned by Schultz (1945), Sjaastad (1962), e.g. Sjaastad (1962: 80) even put forward the question “migration: too much or too little?” and saw migration as an equilibrating mechanism. But they fail to address questions as how business cycles are influenced by labor migration out of agriculture.

[2] Even the large volume of Development Macroeconomics by Agenor and Montiel (1999), e.g., neglects migratory fluctuations associated with business cycles almost completely. Two studies of Todaro (1969) and Harris and Todaro (1970), and a large stock of literature following them, study farmer’s intersectoral migration interacted with urban unemployment, but not with business cycles.

employment in the nonfarm sector? There may be several microeconomic reasons (Sjaastad 1962; Vandercamp, 1971), but also macroeconomic ones. For example, the recession that led to a broad downturn in industrial production in Malaysia certainly contributed to the girl's return decision according to the story above.

In fact, return migration has currently become a serious challenge to economic and social policy in some developing countries after the 2008 economic crisis compelled millions of migratory farmers to go back. It is reported, for example, that around 20 million migrated "farmers" lost their nonfarm jobs in China and had to return to their remote villages (Chen, 2009). While the main concern in the United States and Western Europe is unemployment, the wave of involuntary return migration of former farmers draws most attentions in e.g. China. A few figures may help highlight the difference. During the Great Depression unemployment in the United States reached 13 million in 1933 when total agricultural employment amounted to 10 million only. After the current financial crisis burst in September 2008, unemployment increased to nearly 9 million in the US at the end of 2008, while less than 2.2 million farmers still worked in agriculture (US Government, 2010: Table B35). But the official unemployment in China which does not contain laid-off migratory "farmer-workers" was far below 9 million in 2008 and did not reached an half of laid-off migratory farmer-workers, not to say that agricultural labor in China still surpassed 300 million in 2008 (NBSC, 2009b: Table 4-1). In my opinion, these migrant workers who were forced to return to countryside may also bear the heaviest burden of such a severe economic slowdown in China. The short-run macroeconomic analysis of business cycles has to integrate these migratory fluctuations into its framework and thereby help to explain them.

The present paper tries to show that the long-run declining trend of the agricultural labor share may, particularly during the periods of mass migration out of agriculture, take a wave-form with clearly different rapidity and even reverse movements in the short-run. That means the average and instantaneous velocity of the share's decline could not be the same and the short run fluctuations in the instantaneous velocity should be often-observed macroeconomic phenomena during the modern economic growth. Furthermore, fluctuations in migration, instead of unemployment, may be an intrinsic and significant part of business cycles and work as an "equilibrating mechanism" to exacerbate or mitigate their scales. In the following section we will define indicators to measure farmer out-migrations and velocities of decline in agricultural labor share. With these indicators the short-run fluctuations in migration and particularly their cyclical properties are illustrated in Section II. Section III sets up a model of labor and commodity markets and explains its equilibrium. In the subsequent Section IV equilibrium migration between two points of time will be investigated. Finally, we shall discuss relationships between migration and business cycles in Section V.

I. Measuring Migration of Agricultural Labor Force

According to the "census survivor" technique used in the population research (Ferrie, 2006: 491), net immigration is measured with the equation of $(M_t\text{-}X_t)=(P_t\text{-}P_{t-1})\text{-}(B_t\text{-}D_t)$, where the five variables stand for immigration, emigration, population, birth and death respectively and the subscripts represent time. Given statistical series of P, net migration will be known if data on (B-D) are available. In the same manner, true net intersectoral migration of labor force out of agriculture ($\mathcal{H}$) can be measured as follows [3]

$$(1.1)\qquad \mathcal{H}_t=-(M^A{}_t-X^A{}_t)=(L^A{}_{t-1}-L^A{}_t)+(B^A{}_t-D^A{}_t)$$
$$=(L^A{}_{t-1}-L^A{}_t)+n^A{}_tL^A{}_{t-1}\qquad\qquad (L_t=L^A{}_t+L^N{}_t)$$

where L stands for labor and n for the growth rate of labor in a closed environment, while A and N in the superscripts denote farm and nonfarm sector, respectively. In consideration of the long-run trend of labor transfers out of agriculture, we use $(L^A{}_{t-1}-L^A{}_t)$ in (1.1) instead of the common usage of $(L^A{}_t-L^A{}_{t-1})$ to ensure that $\mathcal{H}$ is positive in the most cases. However, $\mathcal{H}$ is statistically unobservable because data on n^A or on birth and death in a closed farm sector are not available in accessible statistical publications in the most countries of the world.[4] Thus we have to search after substitutes for $\mathcal{H}$. Here are two of them:

$$(1.2)\qquad H_t=(L^A{}_{t-1}-L^A{}_t)+n_tL^A{}_{t-1}$$
$$(1.3)\qquad H^*{}_t=(L^A{}_{t-1}-L^A{}_t)\equiv\Delta L^A{}_t$$

H stands for farmer out-migration under the assumption of $n^A{}_t=n_t$ and H^* for reduction in stock of farming labor without regard to the natural growth of labor in farm sector. Data on L^A and L belong to regularly published statistics and, given a closed economy, n will become known through simple computations. Therefore, H and H^* can be calculated with statistical certainty. Comparing the three measurements, we get

$$(1.4)\qquad \mathcal{H}_t-H_t=(n^A{}_t-n_t)L^A{}_{t-1}>0$$
$$(1.5)\qquad \mathcal{H}_t-H_t^*=n^A{}_tL^A{}_{t-1}>0$$
$$(1.6)\qquad (\mathcal{H}-H^*)-(\mathcal{H}-H)=H-H^*=n_tL^A{}_{t-1}>0$$

That (1.4) holds is based on the assumption of $n^A{}_t>n_t$, that is, farm labor grows more quickly than nonfarm one if the both sectors are closed against each other.[5] And we always assume $n_t>0$ and $n^A{}_t>0$ for (1.4) to (1.6). Under these assumptions there exist the relations of $\mathcal{H}>H>H^*$ as (1.6) shows. They imply that H approaches to $\mathcal{H}$ more closely than H^* does and, therefore, represents

3 Todaro (1969) use S and its increment to represent urban labor and rural-urban migration and Harris and Todaro (1970) use N for the same quantity, while in Mundlak (1979) and Larson and Mundlak (1997) M and m stands for farmer migration and its ratio to farm labor, respectively. Mundlak's usage is accepted by most scholars in the field of research. But M and m usually stand for monetary quantities in the short-run macroeconomics. In consideration of it and of the fact that the most Latin letters are already employed for some specific senses, we select H and h for migration.

4 Johnson (1960: 403) mentioned that the natural increase of the farm population offset about two fifths of the net out-migration from farm to nonfarm areas in the United States during 1950s.

5 Kuznets (1966: 124) estimates that natural rate of growth in agricultural population and consequently in agricultural labor may be three times higher than that of nonagricultural ones.

$\mathcal{H}$ better. Correspondingly, we have two relative indicators h and h^* with [6]

$$(1.7) \qquad h_t = \frac{H_t}{L_t} \equiv \Delta l_t$$

and

$$(1.8) \qquad h_t^* = \frac{H_t^*}{L_t}$$

where $l_t = L^A_t/L_t$ is the agricultural labor share and Δl the difference of agricultural labor shares. While the meaning of (1.8) is straightforward, that of (1.7) needs explanations. From the definition of Δl_t we know

$$\Delta l_t = l_{t-1} - l_t = \frac{L^A_{t-1}}{L_{t-1}} - \frac{L^A_t}{L_t}$$

Because $L_t = (1+n_t)L_{t-1}$, we get

$$(1.9) \qquad \Delta l_t = \frac{L^A_{t-1}}{\frac{L_t}{1+n_t}} - \frac{L^A_t}{L_t} = \frac{1}{L_t}[(1+n_t)L^A_{t-1} - L^A_t] = \frac{1}{L_t}[(L^A_{t-1} - L^A_t) + n_t L^A_{t-1}] = \frac{H_t}{L_t}$$

(1.9) validates $h_t \equiv \Delta l_t$. Indeed, h is merely a convenient symbol for Δl_t since each of the both represents the same rate of farmer out-migration to total labor if $n^A_t = n_t$. h and h^* can be understood as "instantaneous velocities" of the fall in l. But h represents the rate or the velocity better than h^* does because of precedence of H over H^* in representing the true migration. The relation of h and h^* is expressed in (1.10):[7]

$$(1.10) \qquad h_t = h_t^* + \frac{n_t}{1+n_t} l_{t-1} = h_t^* + C_t$$

with

$$C_t = \frac{n_t}{1+n_t} l_{t-1}$$

where $C_t > 0$ and $h_t > h_t^*$ since $l_{t-1} > 0$ and $n_t > 0$. C_t is given because both that l_{t-1} is known in the tth period and that n_t is exogenous to intersectoral allocation of labor force. In the short run with $n_t = 0$, we have $C_t = 0$ and $h_t = h_t^*$.

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[6] Mundlak (1979: 25) calculated migration with an equation essentially same to our Equation (1.2), but did not connect it with Δl_t because he was interested in how H/L^A is determined.

[7] (1.9) can be derived as follows:

$$h_t = l_{t-1} - l_t = \frac{L^A_{t-1}}{L_{t-1}} - \frac{L^A_t}{L_t} = (1+n_t)\frac{L^A_{t-1}}{L_t} - \frac{L^A_t}{L_t} = \frac{L^A_{t-1} - L^A_t}{L^t} + \frac{n_t L^A_{t-1}}{L_t} = h_t^* + \frac{n_t L^A_{t-1}}{(1+n_t)L_{t-1}} = h_t^* + \frac{n_t}{1+n_t} l_{t-1}.$$

II. Some Facts of Fluctuations in Migration of Agricultural Labor

Foster and Rosenzweig (2008: 3054) recently complained the lack of data on out-migration of agricultural labor and found it one of the basic restrictions to migration researches. While recognizing this restriction, we try to arrange available data with the measures defined above. In fact, only with appropriate measures can these data, though often scarce and ambiguous, be processed for researchers and policymakers. We select the United States, the most developed country of the world, and China, the most populous country, for the empirical studies and reveal some facts of fluctuations in farmer migration in the two countries. The United States began modern economic growth with three quarters or more labor force in agriculture, successfully transferred almost all of them into nonagriculture during the last two centuries. Lebergott (1984), Weiss (1992, 1993) and Weir (1992) respectively estimate US total and agricultural labor in the 19th century and/or after when official labor statistics were not available or, by Weir, in parallel with availability of the official statistics. We collect their estimates as well as the official statistics to form two time series on decennial l and h from 1800 to 2000 and display them in Figure I and II. They clearly show the consistent long-run decline in l and the strong short-run fluctuations in h during the whole two centuries, although the three researchers' estimates are deviated from each other obviously. We depict l, h, h^* with the US annual official data from 1948 to 2007 in Figure III and find that h and h^* fluctuated wildly during the post-War era. While decennial data show that agricultural labor migrates, no matter how fast or slow it may be, in only one direction of "out-into-nonagriculture" with an exception of Lebergott's estimation for the first decade of the 19th century (h<0 in Figure I), the annual statistics of the post-War era tells a story of migrations in two directions. In many years during the era labor migrates more into agriculture measured with the indicators we defined.[8] A comparison of Figure III with Figure I and II suggests that the decennial data may prevent annual fluctuations within a whole decade from being discovered. On the other hand, all three indicators of l, h and h^* have become smaller and smaller during the post-War era and should be of no importance for macroeconomic performance in the United States at the present day.

[8] Return migration in this paper refers to increases in L^A measured by $-H$ or $-H^*$. They may also result from the fact that less farmers migrate out than needed to make $H \geq 0$ or $H^* \geq 0$.

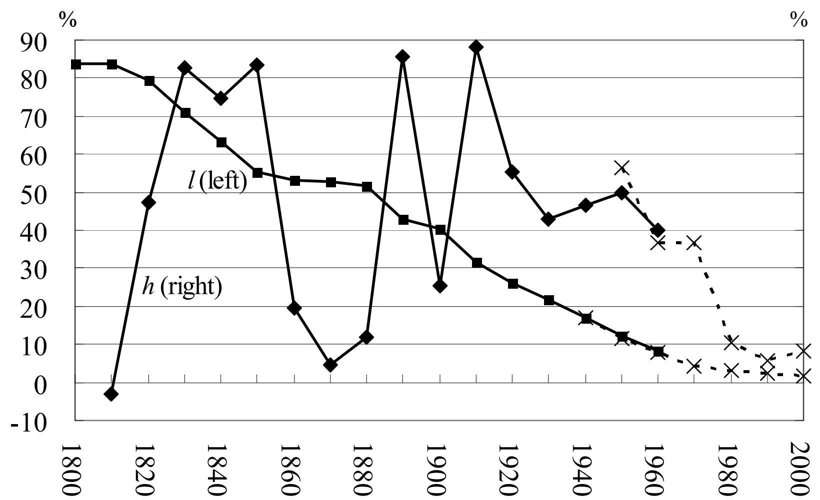

Figure I Declining *l* and fluctuating *h* in the United States, 1800-2000 I

Sources: Lebergott estimates from 1800 to 1960: Lebergott, 1984: 66; official statistics from 1940 to 2000: US Government, 2010, Appendix B, Table B35. Notes: The real and dash graphs represent Lebergott estimates and the official statistics, respectively. Points on l-curve show data of the corresponding year and these on h-curve display data of a decade ending with the corresponding year. L^A includes labor forces in agriculture and fishing in Lebergott's original categories.

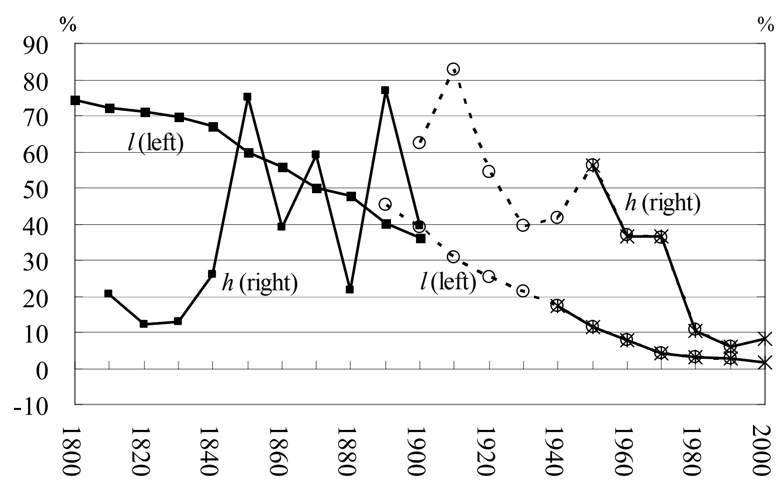

Figure II Declining *l* and fluctuating *h* in the United States, 1800-2000 II

Sources: Weiss estimates from 1800 to 1900: Carter, et al., 2006, Table Ba829-30, slightly deviated from Weiss (1992, 1993). Weir estimates from 1890 to 1990: Carter, et al., 2006, Table Ba470 and Ba472. Official statistics from 1940-2000: US Government, 2010, Appendix B, Table B35. Notes: The left and right real graphs represent Weiss estimates and official statistics, respectively, while the dash curve depict Weir estimates. Otherwise see notes to Figure I.

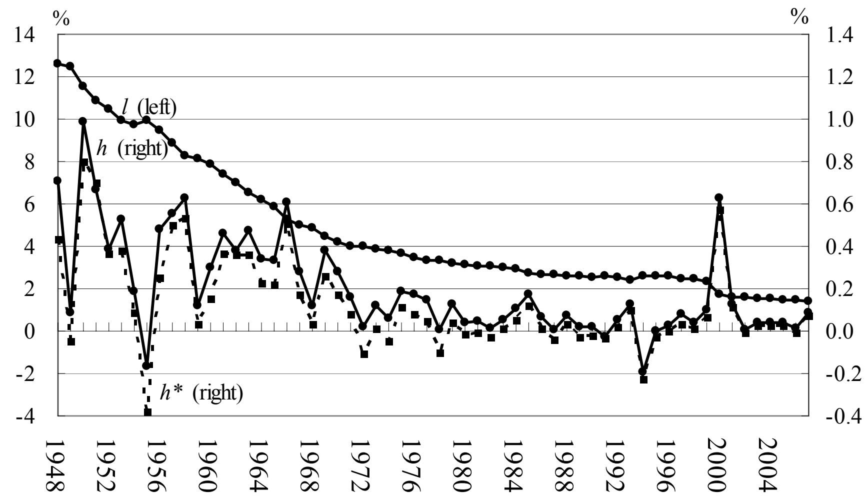

Figure III Declining *l* and fluctuating *h* and h^* in the United States, 1948-2007

Sources: US Government, 2010, Appendix B. Table B35.

In contrast to the United States, the Chinese economy with its agricultural labor share of around 50 percent remains in the midway of labor migration into the capitalist nonagriculture at the beginning of the 21st century. The systematic data of L and L^A date back to 1952 in China. We compute *l*, *h*, h^*, H and H^* with these data to get Figure IV and V. The long-run trend of declining *l* is depicted in Figure IV, with a big break in 1958 and immediately after. China's *l* fell for the first time below 40 percent in 2008 and its *h* often surpassed 2 percent during last two decades. Alone between 2000 and 2008 China's *h* reached more than 10 percentage points. However, what attracts our attention most is the continuous and strong fluctuations in *h* and h^* in Figure IV and in H and H^* in Figure V. It is of special interest that the fluctuations in each of these four indicators have become more regular with cyclical property of duration and amplitude after China began to transform in the direction of market economy in 1978, particularly since 1990s after the Chinese farmers got back their right to search jobs outside their villages and immediate vicinity. It seems that each of *h*, h^*, H and H^* increases continuously for 3 to 5 years, then decreases for another 3 to 5 years, and remains some 3 years at its peak or trough.

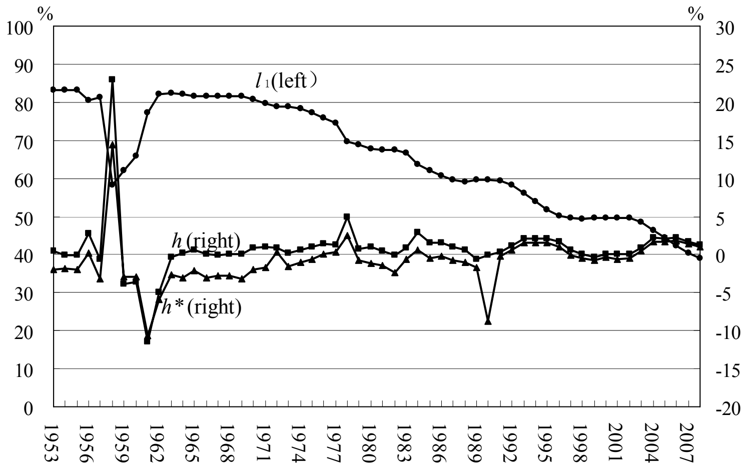

Figure IV Declining l and fluctuating h and h^* in China, 1952-2008

Sources: NBSC, 2005, Table 4; 2009b, Table 4-1, 4-3.

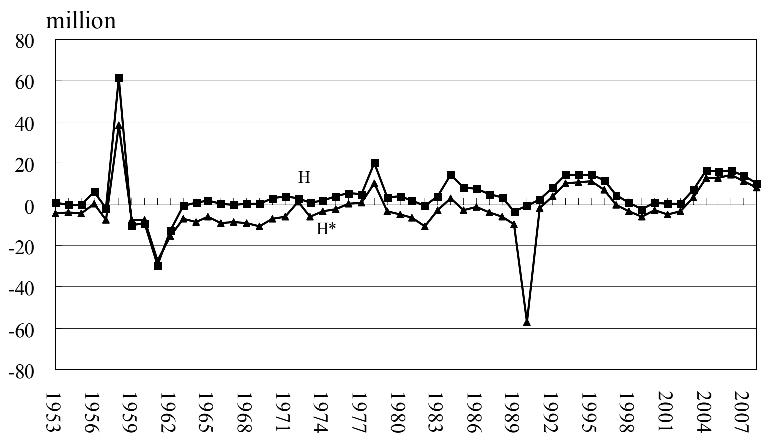

Figure V Fluctuations in H and H^* in China, 1952-2008

Source: as for Figure IV.

As mentioned at the beginning of this paper, the quantitative relationships of unemployment to migration of agricultural labor in China take an essentially different dimension than in the United States. We look at the relationships in China more detailedly. Let U and ΔU stand for unemployment and its increment, respectively. U, similar to L^A, is a stock while ΔU, H and H^* belong to the flows. China's official unemployment data begin with the year of 1978, with which we calculate ΔU as well as u (=U/L) and u^* (=ΔU/L). Data on u, u^*, h and h^* are displayed in Figure VI and on U, ΔU, H and H^* in Figure VII. Both figures make clear that China's u and u^* or U and ΔU almost do not fluctuate in comparison to h and h^* or H and H^* during the period from 1979 to 2008, which results from the fact that U and especially ΔU were quantitatively too small relative to H and H^*. In China, H and H^* often surpassed the mark of 10 million during the period under the review, as Figure VII shows, while U always remained under 10 million and the highest ΔU was less than 1 million. Note that it is ΔU that is comparable to H and H^* because of being flows. We take U to comparison only for highlighting how big the quantitative difference between farmer migration and unemployment can be in some populous developing countries. Here the quantity decides. In 2006, e.g., there were nearly 17 million (H) or 14 million (H^*) agricultural labor forces who for the first time found employment in nonagriculture in China, but only 80 thousand (ΔU) nonfarm workers added to unemployment, while total unemployment (U) did not even reach 8.5 million. It is impossible to imagine that so small new nonagricultural unemployment could lead to so massive migrations of agricultural labor into nonagriculture. The models of Todaro (1969) and Harris-Todaro (1970) trying to explain migrations by means of unemployment should become implausible in face to these facts.

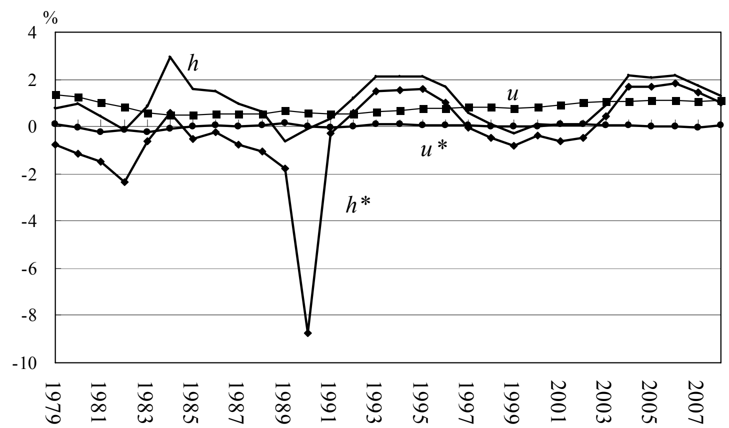

Figure VI Fluctuations in h, h^*, u and u^* in China, 1979- 2008

Sources: Data of L, h and h^*: see Figure IV. Data of U: NBSC, 2005: Table 4; 2009b: Table 4-1.

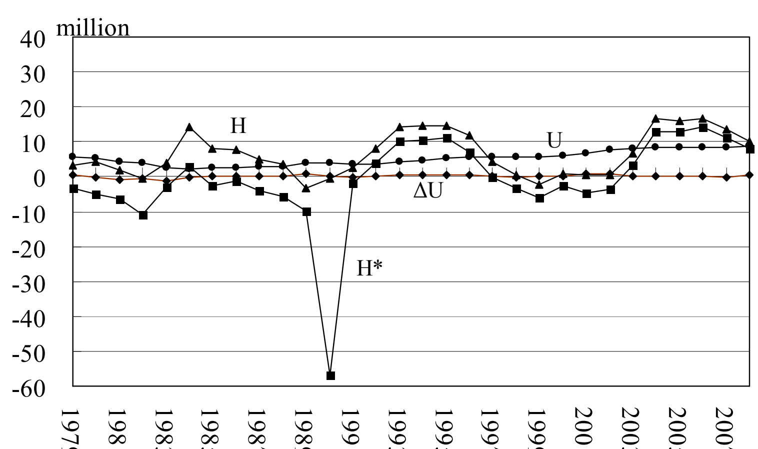

Figure VII Fluctuations in H and H^*, U and ΔU in China, 1979- 2008

Sources: as for Figure V and VI.

We further look at eventual combinations of GDP growth and inflation with economic activity with migration and unemployment in China. Let g represent growth rate of real GDP and introduce data on g from the period under review it into Figure VI to get Figure VIII and that on CPI from 1985 to 2008 as well as on food price from 1994 to 2008 to get Figure IX. A rough comparison between the graphs of g, h and h^* on the one hand and that of g, u and u^* on the other in Figure VIII and that between the graphs of CPI, food price, h and h^* on the one hand and of CPI, food price, u and u^* on the other in Figure IX already suggest that GDP growth and CPI-inflation may have much more closed relations with migration than with unemployment in China. These comparisons also make advisable to study short-run relations between economic activity and intersectoral migrations of agricultural labor in the economies with large scale migrations.

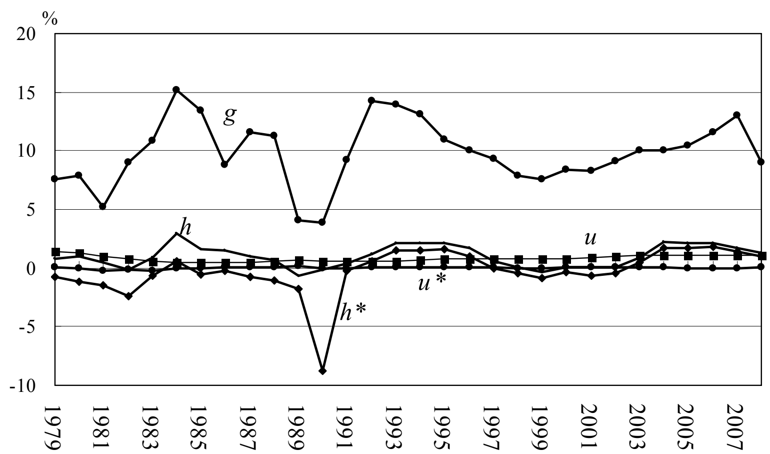

Figure VIII Fluctuations in g, h, h^*, u and u^* in China, 1979-2008

Sources: Date of h, h^* u and u^*: as for Figure VI. Data of g: NBSC, 2009b: Table 2-4.

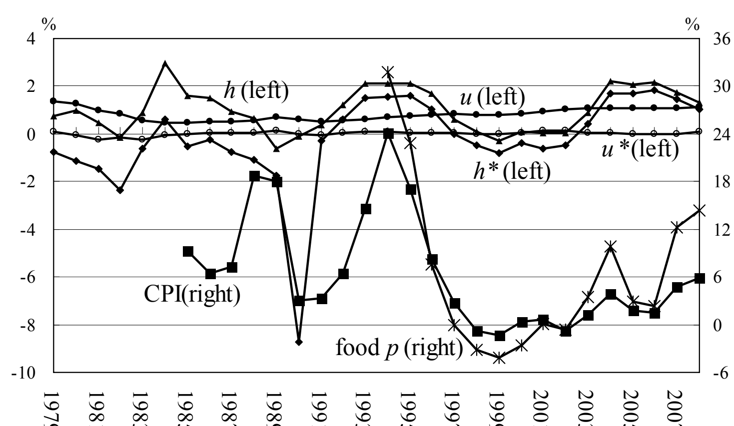

Figure IX Fluctuations in CPI, Food Price, h, h^*, u and u^* in China, 1979-2008

Sources: Date of h, h^* u and u^*: as for Figure VI. Data of CPI, 1985-1993: NBSC, 2005, Table 28;

Data of CPI and food price, 1994-2000: NBSC, 2001, Table 9-6; 2001-2008: NBSC: 2009b, Table 8-6.

III. A Model for the Labor and Goods Markets

In this and the following section we try to set up a short-run macroeconomic framework to analyze the massive intersectoral migration of agricultural labor and business cycles. Ideally, the framework should deal with labor migration and unemployment simultaneously. However, this paper is limited to study migration and, therefore, we assume full employment in the economy concerned. And we accept the usual assumptions for the short-run, that is, constant total capital and labor, fixed sectoral allocation of capital as well as given technology and institutions. Furthermore, it is assumed that:

1) The economy consists of non-capitalist agriculture and capitalist nonagriculture;
2) Nobody involves in both sectors at the same time;
3) Migration takes no time;
4) Each family has only one member who is a worker.

Hu (1994, 1998) supposes a community-family agricultural structure in which use-right of total arable land of the community is distributed to its farm families according to the population principle. No tenure exists. If a farmer migrates out, his land will be redistributed between community families. He can get land to use again if returning to the community. A farmer's income corresponds to all product of the land he uses and the so called agricultural wage rate corresponds to average product of labor. The wage rate may equal to or exceed the so-called subsistence level. However, it will increase as soon as some farmers migrate out of agriculture and leave their land to be cultivated by the remainders freely, and become higher than the subsistence level in case it was at that level earlier, after some farmers migrate out of agriculture and leave their land to be cultivated by remaining farmers freely. The well-known horizontal wage curve proposed by Lewis (1954) does not apply here, irrespective of how low the marginal product of agricultural labor is, provided it is positive. The concept of average-product wage means exactly that the whole net product of the land including those that will be assigned to land and capital in a capitalist sector is held as returns to only labor inputted. Two of the analytical implications of this precapitalist "agricultural wage" should be made explicit. The first one is that farmers compare it with nonfarm wage in making decisions upon their intersectoral migrations, although the latter is determined with the marginal principle. Another implication lies in that this wage can fluctuate and hence respond to market changes.[9]

[9] Other concepts of agricultural wage known in development economics as Lewis' subsistence wage (1954), Fei and Ranis' constant institutional wage (1964) are impossible to be integrated in a short-run analysis since they are not allowed to change flexibly. Recent researches on long-term structural change with two- or three-sector models of growth, some papers of which were mentioned at the beginning of this paper, make use of marginal-product wage for agriculture. Our assumptions of single-family and the agricultural setting imply that the opportunity cost of out-migration for a farmer is marginal as well as average product of his labor in agriculture. The single-family assumption may be reasonable since the number of agricultural households

Based on this agricultural structure and the standard neoclassical structure in nonagriculture, we model the labor and commodity markets as follows:

(3.1) $Y = pY^A + Y^N$

(3.2) $Y^A = f^A(\theta K, lL)$

(3.3) $Y^N = f^N[(1-\theta)K, (1-l)L]$

(3.4) $$w^A = \frac{f^A}{lL}$$

(3.5) $$w^N = \frac{df^N}{d[(1-l)L]}$$

(3.6) $pw^A = w^N$

(3.7) $pY^A = cY,$

(3.8) $L = L^{\sim}$

(3.9) $K = K^{\sim}$

(3.10) $\theta = \theta^{\sim}$

(3.11) $c = c^{\sim}$ ($^{\sim}$ means a constant)

where Y, K and w stand for output, capital and wage rate, respectively, and p (>0) for relative price of farm product with nonfarm product being numeraire, while $\theta \in (0, 1)$ denotes ratio of capital stock in farm sector to total capital and $c \in (0, 1)$ is a variant of Engel's coefficient. We omit the signs for time since we deal with static equilibrium here. Assuming that the Inada conditions apply to both f^A and f^N. Equation (3.6) is the equilibrium condition for labor market, implying that wage rates in both the sectors, weighed by p, must be equalized at equilibrium, which is realized by intersectoral mobility of labor and fluctuations in p. At the same time, Equation (3.7) expresses the equilibrium condition for goods market, that is, market for farm product. Our model economy still has a market for nonfarm product. However, it can be abstracted from the analysis because Walras' law applies. Changes in p are caused by fluctuations in demand for and supply of farm product. We suppose that the economy concerned is so developed that it passed through the so called phase of subsistence. In our economy, farm product

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decreases absolutely along with the out-migration of agriculture labor. Another reason for average-product wage in agriculture is that agriculture may still remain pre- or non-capitalist even in today's developed countries (Friedman, 1978) because of domination of family farms using labor forces mainly from within the family of the farm owners or managers who rent in farm (Hill, 1993, Suits, 1995; Allen and Lueck, 2003). The last but not least reason for average-product wage is that the gap between average product of farm labor and marginal product of nonfarm labor is surely smaller than that between marginal products of both types of labor. According to Maddison (1970) and Restuccia, Yang and Zhu (2008), the gap exists in every country in the sample they studied and average product of farm labor is only some a fifth of that of nonfarm labor in low- and middle-income countries. With the average productivity gap in such a big scale, the gap between sectoral marginal products of labor could not be smaller (Hu, 2008). A possible equilibrium in the intersectoral labor market for short-run analysis may be more plausible with average-product wage than with marginal-product one for agriculture.

an individual consumes is clearly more than for mere subsistence, even when one has to reduce one's food consumption because of decreases in one's income. Based on this assumption, how much an individual consumes farm product will depend on one's preference, income and prices. In the short run, preference is supposed constant and a fixed part, c, of one's income may be distributed for consumption of farm product. In aggregate we have cY in place of the demand function for farm product, $Y^{A,D}$, with

$$(3.12) \quad c = c(Y), \qquad \frac{dc}{dY} < 0,\ 1 > c > \frac{dpY^{A,D}}{dc} \left| \frac{dc}{dY} \right| > 0$$

The inequality $c > (dpY^{A,D}/dc)(dc/dY)$ implies that $pY^{A,D}$ will increase as long as Y rises.[10] The supply of farm product is given by farm production function at p as shown on the left-hand side of (3.7). The model consists of eleven equations with seven unknowns (Y, Y^A, Y^N, p, l, w^A, w^N) and four parameters (θ, K, L, c). Let investigate labor market first. Introducing (3.4) and (3.5) into (3.6) and solving for p gives

$$(3.13) \quad p^L = \frac{lL}{f^A(\theta K, lL)} \frac{df^N[(1-\theta)K,(1-l)L]}{d[(1-l)L]}.$$

where superscript L denotes labor market and

$$(3.14) \quad \frac{dp^L}{dl} = \frac{lL}{f^A(\theta K, lL)} \frac{df^{N,2}[(1-\theta)K,(1-l)L]}{d[(1-l)L]^2}(-L)$$

$$+ \frac{L}{f^A(\theta K, lL)} \frac{df^N[(1-\theta)K,(1-l)L]}{d[(1-l)L]}$$

$$+ lL \frac{df^N[(1-\theta)K,(1-l)L]}{d[(1-l)L]}(-1)\frac{1}{[f^A(\theta K, lL)]^2} \frac{df^A(\theta K, lL)}{d(lL)} L$$

$$= -\frac{lL^2}{f^A(\theta K, lL)} \frac{df^{N,2}[(1-\theta)K,(1-l)L]}{d[(1-l)L]^2}$$

$$+ \frac{df^N[(1-\theta)K,(1-l)L]}{d[(1-l)L]} \frac{L}{[f^A(\theta K, lL)]^2} \left(f^A - lL \frac{df^A(\theta K, lL)}{d(lL)}\right) > 0$$

since

$$\frac{df^{N,2}[(1-\theta)K,(1-l)L]}{d[(1-l)L]^2} < 0$$

[10] It is because the assumption of

$$\frac{dpY^{A,D}}{dY} = c + \frac{dpY^{A,D}}{dc} \frac{dc}{dY} > 0,$$

where $(dpY^{A,D}/dc) > 0$ and $(dc/dY) < 0$.

and

$$f^{\mathrm{A}}\text{-}l\mathrm{L}\frac{\mathrm{d}f^{\mathrm{A}}(\theta\mathrm{K},l\mathrm{L})}{\mathrm{d}(l\mathrm{L})}>0$$

The last inequality holds because total output of a sector must exceed the product of quantity of one of production factors inputted and its marginal product in the sector. For the goods market we rewritten Equation (3.7) as follows

$$p^{\mathrm{G}}\mathrm{Y}^{\mathrm{A}} = c(p\mathrm{Y}^{\mathrm{A}} + \mathrm{Y}^{\mathrm{N}}) = cp\mathrm{Y}^{\mathrm{A}} + c\mathrm{Y}^{\mathrm{N}}$$

where superscript G represents goods market. Arranging it and solving for p to get

$$(3.15)\quad p^{\mathrm{G}}=\frac{c}{1-c}\frac{\mathrm{Y}^{\mathrm{N}}}{\mathrm{Y}^{\mathrm{A}}}=\gamma\frac{f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{f^{\mathrm{A}}(\theta\mathrm{K},l\mathrm{L})}$$

and

$$(3.16)\quad \gamma=\frac{c}{1-c}\qquad\qquad \gamma>0,\ \frac{\mathrm{d}\gamma}{\mathrm{d}c}>0$$

Differentiate (3.15) with respect to l gives

$$(3.17)\quad \frac{\mathrm{d}p^{\mathrm{G}}}{\mathrm{d}l}=\gamma\frac{1}{f^{\mathrm{A}}(\theta\mathrm{K},l\mathrm{L})}\frac{\mathrm{d}f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]}(\text{-L})$$

$$+\gamma f^{\mathrm{N}}[(1\text{-}\theta)\mathrm{K},(1\text{-}l)\mathrm{L}](-1)\frac{1}{[f^{\mathrm{A}}(\theta\mathrm{K},l\mathrm{L})]^2}\frac{\mathrm{d}f^{\mathrm{A}}(\theta\mathrm{K},l\mathrm{L})}{\mathrm{d}(l\mathrm{L})}\mathrm{L}$$

$$=-\gamma\mathrm{L}\frac{1}{[f^{\mathrm{A}}(\theta\mathrm{K},l\mathrm{L})]^2}\{f^{\mathrm{A}}(\theta\mathrm{K},l\mathrm{L})\frac{\mathrm{d}f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]}$$

$$+f^{\mathrm{N}}[(1\text{-}\theta)\mathrm{K},(1\text{-}l)\mathrm{L}]\frac{\mathrm{d}f^{\mathrm{A}}(\theta\mathrm{K},l\mathrm{L})}{\mathrm{d}(l\mathrm{L})}\}<0$$

Without lose of generality, we draw two lines of p^{L} and p^{G} in Figure X with $p^{\mathrm{L}}(l)$ running upwards and $p^{\mathrm{G}}(l)$ downwards. Figure X shows, on the one hand, that p^{L} has to rise to maintain $p^{\mathrm{L}}w^{\mathrm{A}}=w^{\mathrm{N}}$ in the labor market if more labor engages in agriculture since higher l implies lower w^{A} and higher w^{N}. On the other hand, higher l will produce more farm product when checking aggregate output to increase, which will result in falls in p^{G} to balance the demand and supply in goods market. Therefore, the level of price for maintaining labor market in equilibrium, p^{L}, will be higher than that of p^{G} for keeping goods market in balance if $l=l^{\#}$, as shown in Figure X. In the opposite case, p^{L} will be lower than p^{G} if $l=l^{*}$ in the figure. In both the cases, no markets can equilibrate and the economy fluctuates. But changes in p and l will bring the two markets in equilibrium at the same time. If, e.g., the economy happens at $l=l^{\#}$, p^{L} cannot rise high enough to prevent farm labor from out-transfer because of decreasing p^{G}, so l will go down. Otherwise, l

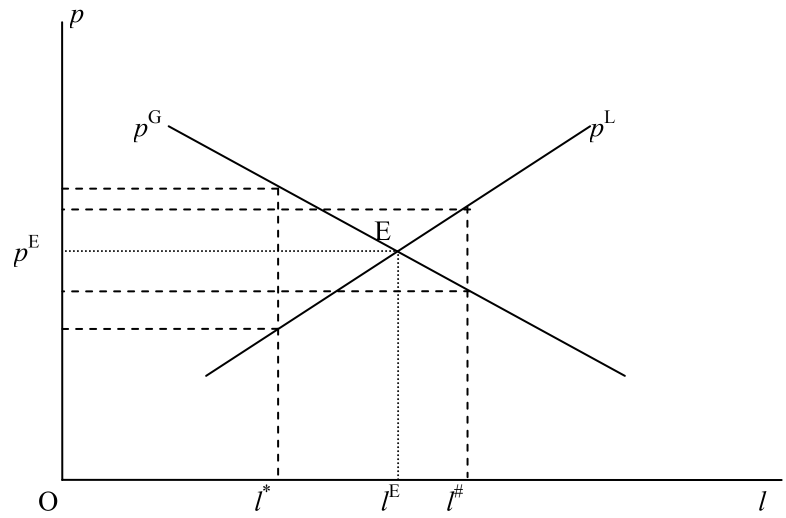

Figure X Equilibrium of Relative Price and Sectoral Allocation of Labor

will go up from the point of $l=l^*$ because p^L cannot fall enough to hold $p^L w^A=w^N$ for keeping nonfarm labor in remaining in face of increasing p^G. Taking p^L and p^G into an equation, we get

$$(3.18) \qquad \frac{l\mathrm{L}}{f^{\mathrm{A}}(\theta\mathrm{K}, l\mathrm{L})} \frac{\mathrm{d}f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]} = \gamma \frac{f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{f^{\mathrm{A}}(\theta\mathrm{K}, l\mathrm{L})}$$

(3.18) has only one unknown, l. As proved in the appendix, there is one and only one $l \in (0, 1)$, l^E, which satisfies (3.18) and thus makes $p^L=p^G=p^E$, that is, at l^E the level of price an equilibrium in labor market needs is exactly that of price which realizes equilibrium in goods market. In other words, at p^E the average product of farm labor of l^EL is as high as the marginal product of nonfarm labor of (1-l^E)L, while farm output harvested by l^EL also equals demand for it induced from the aggregate output produced together by l^EL and (1-l^E)L in both sectors again at p^E.

In order to highlight mechanisms for equilibrium of the model, we use another figure further. In Figure XI below, the horizontal axis represents fixed total labor of the economy, L. It is allocated between the farm and nonfarm sectors. The vertical dash line AB represents a certain allocation. Farm labor is measured from the left-hand origin towards the right and nonfarm labor from right to left. Correspondingly, Y^A starts from the left-hand origin and rises rightwards while Y^N begins from the right-hand origin and rises leftwards. Both graphs are drawn based on the given capital stocks θK and (1-θ)K. We assume higher labor productivity in the nonfarm than in the farm sector, hence a same quantity of nonfarm labor will produce more than that of farm labor does and the graph of Y^N curves up more steeply than that of Y^A in Figure XI. The graph of Y^A is weighted by p in order to make it comparable with Y^N. Therefore, both the left- and right-hand vertical axes measure the sectoral and aggregate output in term of nonfarm product and A, B on Line AB are additive to Y since A=$pY^A(l\text{L})$ and B=$Y^N[(1-l)\text{L}]$. Straight lines combining the left-hand origin, O^A, and points on pY^A help express the average value products of farm labor. Their angles with the horizontal axis, α, represent the average value product by

$$\text{tg}\alpha = p\frac{Y^A}{l\text{L}} = pw^A$$

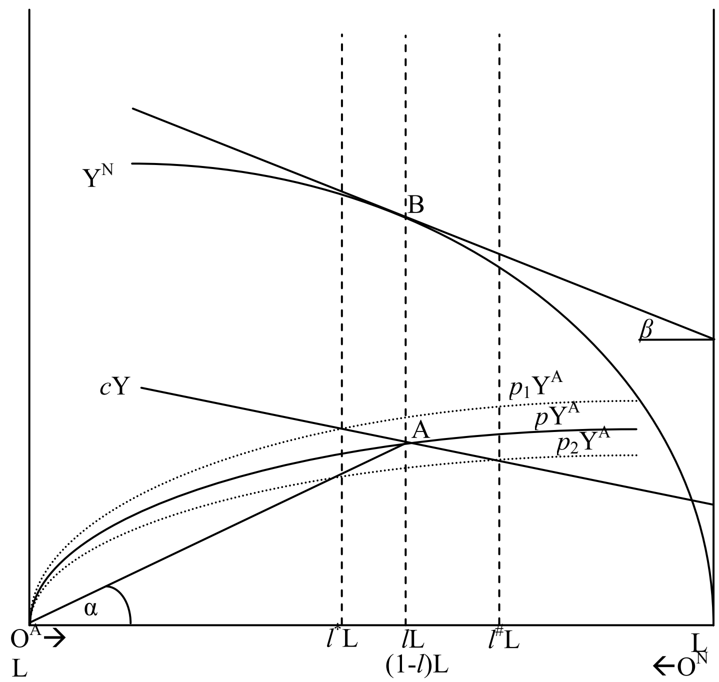

Figure XI Simultaneous Equilibrium of Labor and Goods Markets

From point Z on the right-hand vertical axis above, a line ZB is drawn upwards and left to be tangent at B on Y^N. Its intersection with the horizontal at Z forms an angle β and

$$\text{tg}\beta = \frac{\text{d}f^N[(1-l)\text{L}]}{\text{d}[(1-l)\text{L}]} = w^N$$

Therefore, the equilibrium condition of (3.6) is converted geometrically into

(3.19) $\alpha = \beta$

for Figure XI. The intersectoral labor market will equilibrate at Line AB when (3.18) is satisfied and L will be assigned to the farm and the nonfarm sectors, respectively. At this allocation, individuals have no incentive to migrate between the two sectors.

As Figure XI shows, fluctuations in p can be depicted by related ascending or descending movements of pY^A with Y^A being unchanged. But as soon as p fluctuates, α must change as well and the original equilibrium on labor market break. We integrate demand function for farm product, cY, into Figure XI to investigate p. Note that cY is dependent on Y, not on labor measured on the horizontal axis. Considering the graph of Y. Because of $Y=pY^A+Y^N$, we get [11]

$$(3.20) \quad Y(l)=pY^A(lL) + Y^N[(1-l)L] \qquad \frac{dY(l)}{dl} < 0$$

according to the assumptions of full employment and lower farm productivity. Therefore, Y is minimal if all labor forces concentrate in farm production. Y will keep in increasing along with continuous decline in l. Hence, a graph of Y should start from a point E (>0) on the right-hand vertical axis and run up leftwards with its values being fixed by adding $pY^A(lL)$ and $Y^N[(1-l)L]$ at each allocation line in the domain of $1>l>0$. Combining with the graph of Y, we draw a curve for $pY^{A,D}=cY$ which will, as same as Y, go from E up to the left-hand side monotonously. But cY rises much more slowly than Y because $dc/dY<0$. For the sake of convenience and no loss of generality, we draw a line for cY in Figure XI. The goods market will come to equilibrium at A in Figure XI where cY and pY^A intersect, meaning that demand for and supply of farm product match at p. However, it depends on a certain labor allocation. The demand for farm product will not match its supply if allocation lines lie right or left to Line AB. For example, there will be $cY(l^{\#}L)<pY^A(l^{\#}L)$ and p must fall if labor allocation line happens on the right of Line AB in Figure XI. When it lies on the left of AB, however, p will rise because $cY(l^{*}L)>pY^A(l^{*}L)$. Both examples highlight that p must change as soon as labor reallocates between the two sectors. In fact, Figure XI shows the simultaneous equilibrium for our labor and goods market model. At A in Figure XI, three graphs of pY^A, cY and AB intersect and both equilibrium conditions of $\alpha=\beta$ and $pY^A=cY$ hold at the same time. Therefore, A represents the solution of Equation (3.18).

IV. Equilibrium Migration of Labor

In order to understand intersectoral migration of agricultural labor we need a concept of equilibrium migration. But migration of labor refers to at least two neighboring points of time between which it occurs. The economy at a point of time, t, is characterized by a set of the parameters $(\theta_t, K_t, L_t, c_t)\in(\theta, K, L, c)$, t=1, 2, …, i, ... It is proved in the appendix there exists a set of values of unknowns $(l_t, p_t)\in(l, p)$ to $(\theta_t, K_t, L_t, c_t)$ which realizes equilibrium of the economy at t, t=1, 2, …, i, ... Let t^* denote t+i and assume that the interval of time between t and t+i is well defined [12] and that $L_t=L_{t*}=L$ to simplify our analysis. Labor migration between t and t^*

[11] Differentiating Y(l) will give $dY(l)/dl=pL[dY^A/d(lL)]+Y^A(dp/dl)-L\{dY^N/d[(1-l)L]\}$. Because $dp^G/dl<0$ and $|dY^N/d[(1-l)L]|>p[dY^A/d(lL)]$, we get $dY(l)/dl < 0$.

[12] "Well-defined" means here on the one hand that between t and t^* there is a period consisting of many time points t+1, …, t+(i-1) where adjustments take place. On the other, the between-period must be short so that

is computed as $H_{t,t*}=(l_t-l_{t*})L$.[13] $H_{t,t*}$ could be seen as equilibrium migration since l_t and l_{t*} are the equilibrium values at t and t^*, respectively. But this does not help understand labor migration because with it non-equilibrium migrations cannot be found. We have to do further. Considering an economy develops from t to t^*. What new the economy offers at t to itself at t^* is its savings at t for new capital at t^*, I_t. Supposed there are not depreciations in capital stock between t and t^*, that is, $I_t=\Delta K_{t*}$. Thus, we have $(\theta_{t*}, K_{t*}, L, c_{t*})=(\theta_{t*}, K_t+\Delta K_{t*}, L, c_{t*})$ where K_t and ΔK_{t*} are known after the time point t because I_t is determined at t. It is imaginable that there may be a set of the parameters $(\theta_{t*}^E, K_t+\Delta K_{t*}, L, c_{t*}^E)\in(\theta_{t*}, K_t+\Delta K_{t*}, L, c_{t*})$ at t^* which can leads to a set $(l_{t*}^E, p_{t*}^E)\in(l_{t*}, p_{t*})$ with $p_{t*}^E=p_t$. Thus, the equilibrium migration, $H_{t,t*}^E$, could be defined as $(l_t-l_{t*}^E)L$ or as follows:

Intersectoral migration of agricultural labor force along with capital accumulation and constant total labor during a well-defined interval of time between two time points of t and t^*, $H_{t,t*}=(l_t-l_{t*})L$, is in comparative static equilibrium if there are $p_{t*}w^A_{t*}=w^N_{t*}$, $c_{t*}Y_{t*}=p_{t*}Y^A_{t*}$ and $p_{t*}=p_t$ at t^*, given $p_tw^A_t=w^N_t$ and $c_tY_t=p_tY^A_t$ at t.[14]

We illustrate this definition with Figure XII where bold curves indicate the economy in equilibrium at t^*. Assume that at t, a part of both profits that nonfarm firms get and wages that farm and nonfarm labor forces earn will be saved for investments, while parts of nonfarm product are manufactured to satisfy investment demands. Investments will enhance capacity. With capital augmentations in both the sectors, the graphs of Y^A and Y^N will run steeper, meaning a certain labor force can produce more at t^*. The investments are assumed to be allocated "adequately" between the two sectors to, with related labor migrations, ensure concerted growths of Y^A and Y^N so that $c_{t*}Y_{t*}=p_{t*}Y^A_{t*}$ and $p_{t*}w^A_{t*}=w^N_{t*}$ and $p_{t*}=p_t$ at t^*. Therefore, the economy develops with capital enhancements, output growth, and wage increases which are reflected in $\alpha_{t*}>\alpha_t$ in Figure XII. In this course, the speed at which cY and Y^A rise will be smaller than that for Y and much smaller than that for Y^N because of $dc/dY<0$. Hence, production extensions will be implemented mainly in the nonfarm sector. Nonfarm investments raise marginal productivity of nonfarm labor and lead to $w^N>pw^A$, attracting migration of more labor force out of farm sector, while investments in agriculture with resulting improvement in labor productivity in kind make the out-migration of farmers macroeconomically feasible. Thus, agricultural labor will transfer into nonfarm sector continuously along with capital accumulations. Hence, the left-shift of the allocation line AB to A^*B^* gives the equilibrium migration of agricultural labor $H_{t,t*}=(l_t-l_{t*})L>0$.

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equilibrium is not deprived of its sense for the short-run analysis.

[13] $H_{t,t*}=(1+n^A_{t,t*})l_tL_t-l_{t*}L_{t*}$ if farm labor grows at the rate of $n^A_{t,t*}$.

[14] The definition can be imagined in Kaldor's pattern (1961) for the long run: A unit of farm product would be exchanged for unlimited nonfarm ones in the course of time if p go still higher or all farm product could not be worth a unit nonfarm one if p would tend still lower. In the United States, p rose in the 19th century and remained in an interval and fluctuated strongly in the first half of the 20th century, but fell after the World War II. In general, p does not show clearly de- or increasing trends during the last two centuries of out-migration of agricultural labor (Dennis and Iscan, 2008; 2009).

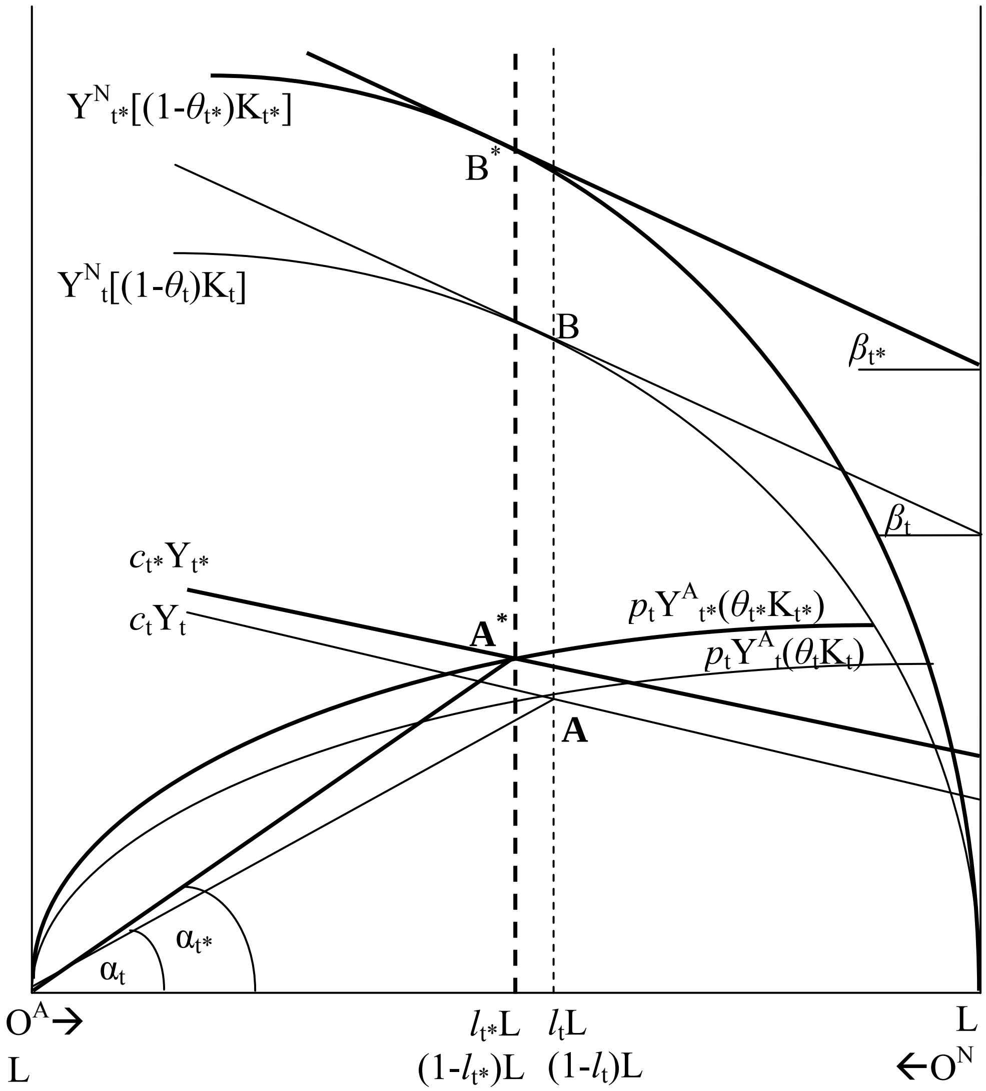

Figure XII Migration in Comparative Equilibrium

The definition and its illustrations in Figure XII should be regarded as a working hypothesis in this paper. The essence of the hypothesis lies in that intersectoral reallocations of labor and capital after a one-time change in total capital can lead to a new equilibrium with the level of price same to that before the change. Here are some tentative explanations. According to assumptions made just above, K_t, ΔK_{t*} and thus K_{t*} are known after the time point t. What we need to know is values of θ_{t*} or the intersectoral allocations of K_{t*}. In order to get to this knowledge, however, we first need to know how ΔK_{t*} is allocated between farm and nonfarm sector at t^*. Let μ stand for ratio of investments in the farm sector to total investments, $\mu_{t*}=\Delta K^A_{t*}/\Delta K_{t*}$ and $\mu\in[0,1]$. The capital stock of the farm sector at t^*, K^A_{t*}, can be evaluated through two equations as follows

(4.1) $K^A_{t*}=\theta_{t*}(K_t+\Delta K_{t*})$

(4.2) $K^A_{t*}=\theta_t K_t+\mu_{t*}\Delta K_{t*}$

Combining the both and solving for θ_{t*}, we obtain

$$(4.3)\qquad \theta_{t*}=\frac{\theta_t K_t+\mu_{t*}\Delta K_{t*}}{K_t+\Delta K_{t*}}=\frac{\theta_t}{1+g_{K,t*}}+\frac{g_{K,t*}}{1+g_{K,t*}}\mu_{t*}$$

$$=\theta_{t*}(\mu_{t*})\qquad\qquad d\theta_{t*}/d\mu_{t*}>0$$

where $g_{K,t*}=\Delta K_{t*}/K_t$ is the growth rate of total capital stock between t and t^*, $g_{K,t*}>0$. Obviously, $\theta_{t*}(\mu_{t*})$ is a linear function. Since θ_t and $g_{K,t*}$ are known after the time point t, we will know about θ_{t*} as soon as μ_{t*} is determined.

We use Figure XIII to see how to find $\mu^E_{t*}\in\mu_{t*}$ which leads to $\theta^E_{t*}\in\theta_{t*}$. Changes in K, θ, μ and l are reflected in shifts of graphs of Y^A, Y^N and AB in Figure XIII. Imagine that we hold $p=p_t$ when adjusting μ. It is easy to see that p will increase if $\mu=0$, that is, if all investments are implemented in nonfarm sector and Y^N ascends to its highest position within the limit made by ΔK_{t*}, while Y^A remains unchanged, which leads to too much demand for farm product as well as for labor force from nonfarm firms, and that p will decrease if $\mu=1$ when Y^A ascends to its highest position and Y^N descends back to Y^N_t, which causes too much supplies on both the markets. Starting from the case of $\mu=0$, μ must rise in order to keep $p=p_t$, thus a fraction of ΔK_{t*} is transferred into farm sector, which pushes Y^A and with it p_tY^A up and Y^N down from its highest position with $\mu=0$. Continuing to raise μ as long as p tends to increase and turning to reduce μ if p begins to decrease. In raising and reducing μ continuously we shall find $\mu^E\in\mu$ that shifts p_tY^A and Y^N to such the positions where, with corresponding movements of the allocation line, $p_tY^A_{t*}=c_{t*}(p_tY^A_{t*}+Y^N_{t*})$ and $p_t(Y^A_{t*}/l_{t*}L)=dY^N_{t*}/d[(1-l_{t*})L]$ simultaneously.

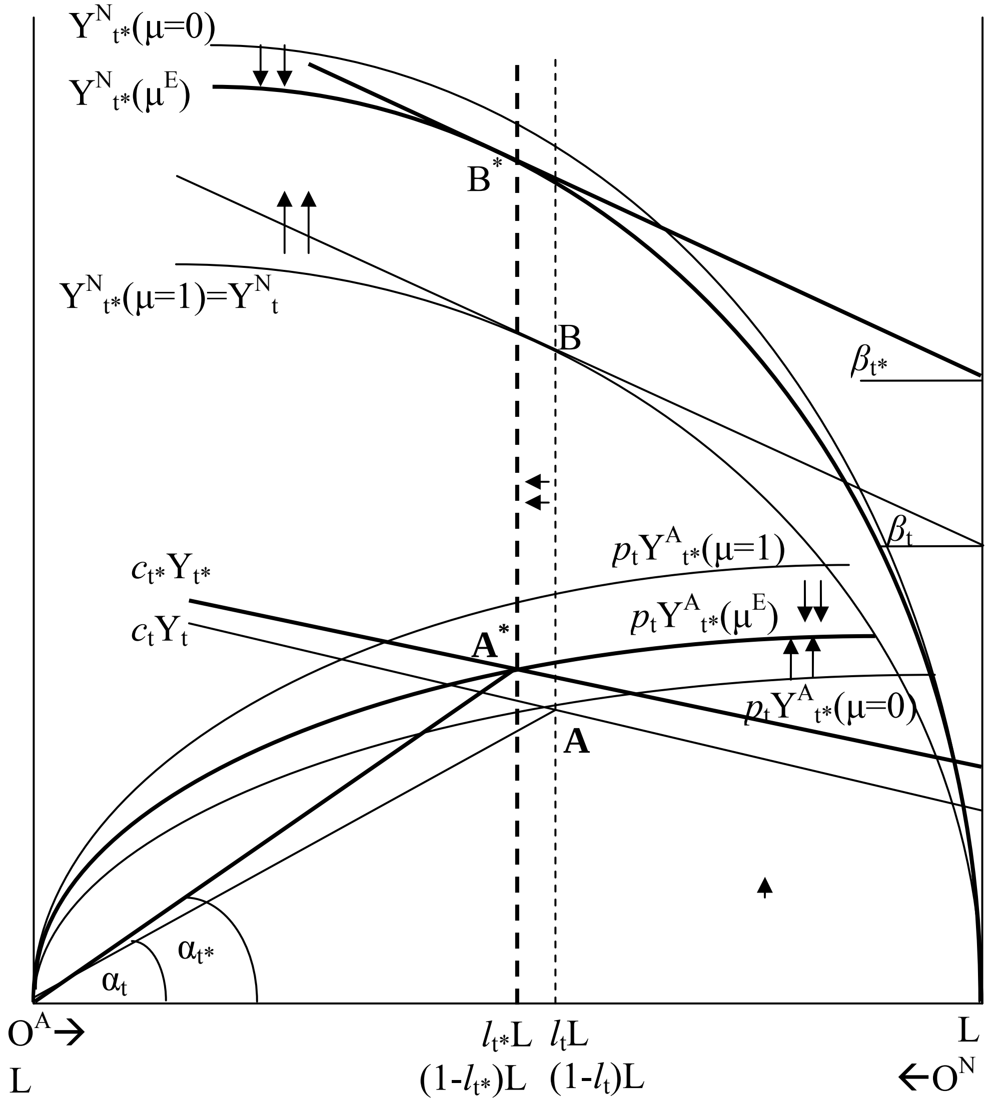

Figure XIII Existence of Equilibrium Migration

The intuitions illustrated in Figure XIII can be partly proved here. Given p_t^E being equilibrium value at t evaluated from Equation (3.5) after l_t^E is known through solving (3.18), the total differential of p_t^E with respect to K and θ is

$$dp_t^E=\gamma\frac{1}{f^A(\theta K, lL)}\frac{df^N[(1-\theta)K,(1-l)L]}{d[(1-\theta)K]}(-K)d\theta$$

$$+\gamma\frac{1}{f^A(\theta K, lL)}\frac{df^N[(1-\theta)K,(1-l)L]}{d[(1-\theta)K]}(1-\theta)dK$$

$$-\gamma f^{N}\frac{1}{[f^{A}(\theta K,lL)]^{2}}\frac{df^{A}(\theta K,lL)}{d(\theta K)}Kd\theta$$

$$-\gamma f^{N}\frac{1}{[f^{A}(\theta K,lL)]^{2}}\frac{df^{A}(\theta K,lL)}{d(\theta K)}\theta dK$$

Let $dp_t^E=0$ and arrange it to

$$(4.4)\qquad \frac{d\theta}{dK}=\frac{1}{R}\{\gamma(1-\theta)\frac{1}{f^{A}}\frac{df^{N}}{d[(1-\theta)K]}-\gamma\theta f^{N}\frac{1}{[f^{A}]^{2}}\frac{df^{A}}{d(\theta K)}\}$$

where

$$R=\gamma K\frac{1}{f^{A}}\frac{df^{N}}{d[(1-\theta)K]}+\gamma Kf^{N}\frac{1}{[f^{A}]^{2}}\frac{df^{A}}{d(\theta K)}\qquad R\neq 0,\ R>0.$$

The existence of (4.4) implies that there must, to every change in K, be at least one corresponding change in θ that makes p stable as K changes. The direction of changes in θ depends on the numerator of the right-hand side of (4.4). It can be rewritten as follows

$$(4.5)\qquad \gamma\frac{1}{f^{A}}\{(1-\theta)\frac{df^{N}}{d[(1-\theta)K]}\frac{K}{K}\frac{f^{N}}{f^{N}}-\theta f^{N}\frac{1}{f^{A}}\frac{df^{A}}{d(\theta K)}\frac{K}{K}\},$$

$$=\gamma\frac{f^{N}}{f^{A}}\frac{1}{K}\{(1-\theta)K\frac{df^{N}}{d[(1-\theta)K]}\frac{1}{f^{N}}-\theta K\frac{df^{A}}{d(\theta K)}\frac{1}{f^{A}}\}$$

$$=\gamma\frac{f^{N}}{f^{A}}\frac{1}{K}(e_K^N-e_K^A)$$

where $e_K^N\in(0,\ 1)$ and $e_K^A\in(0,\ 1)$ represent output elasticities of capital of the two sectors, respectively. Thus, the ranges of values of $d\theta/dK$ are given as follows:

$$(4.6)\qquad \frac{d\theta}{dK}\begin{cases}>0 & e_K^N>e_K^A\\ =0 & e_K^N=e_K^A\\ <0 & e_K^N<e_K^A\end{cases}$$

That is, θ will rise if one percentage growth of capital can cause more percentage increments of output in nonfarm than in farm sector in order to keep p stable when total capital increases, and it will fall in the opposite case. Only when both elasticities are equal does θ not change along with growth of capital, which is excluded since labor productivities are assumed different in both sectors. (4.6) also shows that there may be only one $\theta^{*}\in\theta$ to a certain change in K which can keep p_t^E stable. In any case, θ seems to be a powerful mechanism to stabilize economic development along with capital accumulations.

V. Migrations and Business Cycles: A Discussion

What trigger the short-run fluctuations on labor and/or goods market are external and internal shocks. From the hypothesis explained above one of the possible sources of shocks may be unexpected and large changes in each of the four parameters (θ, K, L, c). For example, $\mu \neq \mu^E$ makes $\theta \neq \theta^E$ which allocates capital stock between the farm and nonfarm sectors inadequately and leads to too high or too low p and with it economic fluctuations. Figure XI may be a useful tool for the analysis of these fluctuations and resulting adjustments. $\mu < \mu^E$ means, e.g., too much investments in nonfarm sector, which will drive up the graph of Y^N, widen β to surpass α in Figure XI. Hence farm labor migrates out to nonfarm activity for more income. The economy booms. But after a while p will rise because of both increased cY as a result of higher Y and stagnated Y^A caused by too less investments in agriculture combined with massive out-migration of farm labor. Clearly rising p pushes w^N up since nonfarm workers appraise their wages by the means of quantity of farm product they can exchange for. The economy may go into the phase of inflation measured by rapid depreciations in the numeraire against farm product.[15] As p and w^N increase strongly, nonfarm production will be less profitable and some firms could go bankrupt, which leads the economy to slowdown. Then p and w^N will turn to fall because of decreasing demands for farm product and labor. Some migrated labor is even forced to go back to agriculture. At lower p and w, the economy will invest again, that is, $\mu < \mu^E$, more in nonfarm sector and begin a new round of its business cycles.

To substantiate the concrete economic meanings and derive implications for economic policy, we consider macroeconomic performance in China in the last years. Because of lack in data our discussions are very limited. China began to publish data on shares and growth rates of investments in agriculture and nonagriculture in 2007, which are, with sectoral shares in GDP, rearranged in Table I. It shows that agricultural investment share was much less than its output share and even tended diminishing until 2008 when investment in agriculture grew sharply at 50%. It may suggest $\mu < \mu^E$ in China at least in 2006 and 2007. China's economy boomed in these years as depicted in Table II when labor transferred from farm to nonfarm sector in large scale and urban unemployment even decreases in 2007. At the same time, Table II points out again the comparative importance of migration to unemployment for macroeconomic performance in China. As predicted by our model, food price went up to 12.3% abruptly in 2007 in comparison with 2.3% in 2006 and brought CPI to be tripled as shown in Table III. It is said that 80 percent of growth of CPI was contributed by growth of food price in 2007 and 2008 (NBSC, 2008a; 2009a). That means strong increases in relative price of food to other commodities included in CPI. The economy had to adjust and slower its growth. Out-migration of agricultural labor became smaller despite large investments in nonfarm sectors, even return migration happened, as mentioned at the beginning of this paper.

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[15] As shown in Figure IX, changes in both CPI and food price index take very similar patterns in China from 1994 to 2008 after China liberated prices of most farm products in the early 1990s.

Year	Share in GDP			Share in Investment in Fixed Assets			Growth Rate of Investment		
	Total	Agri-culture	Nonagri-culture	Total	Agri-culture	Nonagri-culture	Total	Agri-culture	Nonagr-iculture
2005	100	12.2	87.8	100	2.62	97.38			
2006	100	11.3	88.7	100	2.50	97.50	23.9	18.3	24.1
2007	100	11.1	88.9	100	2.48	97.52	24.8	23.8	24.9
2008	100	11.3	88.7	100	2.93	97.07	25.9	48.8	25.3

Table I Sectoral Shares in GDP and Investment in China, 2005-2008

Sources: Ratio of GDP: NBSC, 2009b, Table 2-2. Share and growth rate of investment: NBSC, 2007, Table 6-1; NBSC, 2008b, Table 5-1; NBSC, 2009b, Table 5-1.
Notes: Data on both shares in GDP and one growth rate of investment are calculated without removing the factor of price. It is not clear at which prices the data on investment shares are calculated in the sources.

Year	*g*	*l*	*h*	H	U	dU	*u*	*u**	dU/H
	%	%	%	million	million	million	%	%	%
2005	10.4	44.31	2.08	15.95	8.39	0.12	1.09	0.02	0.75
2006	11.6	42.15	2.16	16.67	8.47	0.08	1.10	0.01	0.48
2007	13.0	40.41	1.75	13.59	8.30	-0.17	1.07	-0.02	-1.25
2008	9.0	39.12	1.29	10.11	8.86	0.56	1.13	0.07	5.54

Table II Growth Rate of GDP and Labor Market in China, 2005-2008

Sources: as for Figure IX.

Year	Per Capita Annual Disposable Income of Urban Households		Per Capita Annual Net Income of Rural Households		Engel's Coefficient of Urban Households	Engel's Coefficient of Rural Households	CPI	Food Price Index
	Year of 1978=100	Growth rate	Year of 1978=100	Growth rate				
		%		%	%	%	%	%
2005	607.4	9.60	624.5	6.21	36.7	45.5	1.8	2.9
2006	670.7	10.42	670.7	7.40	35.8	43.0	1.5	2.3
2007	752.5	12.20	734.4	9.50	36.3	43.1	4.8	12.3
2008	815.7	8.40	793.2	8.00	37.9	43.7	5.9	14.3

Table III Engel's Coefficients and Price Indexes in China, 2005-2008

Sources: Households income and Engel's coefficients: NBSC, 2009b, Table 9-2. CPI and food price: .NBSC, 2009b, Table 8-6..

We use Figure XI to illustrate the adjustments of Chinese economy. Starting from a demand shock which suddenly raises demand sharply and pushes c up to $c' > c$.[16] In Figure XIV cY moves up to c'Y> pY^A on the allocation line AB and p rises accordingly. If the adjustments take place only and wholly on goods market, p will rise to p', pulling pY^A up to p'Y^A with unchanged Y^A. p'Y^A intersects on both cY' and AB at A' where demand meets supply on goods market again. p'Y^A forms a curve of O^{A}AA'A$^\#$ and kicks twice at A and A', representing a one-time push by p rising to p'.

[16] China's Engle coefficient rose in 2007 and 2008 although the average households increased their real incomes clearly in both years as shown in Table III. But the rise may not be a puzzle because growth rates of households' real income were lower than that of food price, that is, real income will decrease if measured by number of food it can purchase.

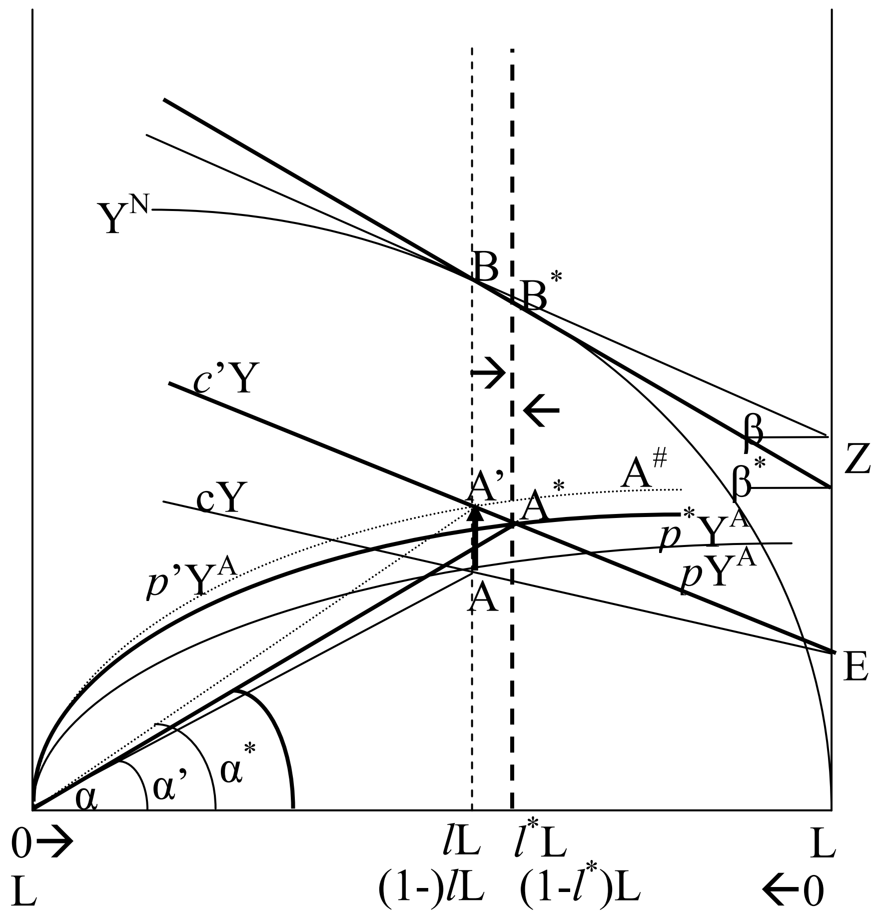

Figure XIV Fluctuation in Migration and Return to Equilibrium

However, the balance on goods market at A' is not stable because of α'>α=*β* following the leftward rotations of O^AA to O^AA'. Equilibrium on labor market also breaks. A part of nonfarm labor will transfer to farm sector for higher earnings. Even if it is realized partly, Y^A will rise, which brings goods market out of balance again since *p* must change further to respond to increases in supply. But changes in *p* have effects on sectoral wage comparisons and labor market gets into fluctuations once more. The interactions of goods and labor market make clear that no single market can absorb shocks alone. Any shocks which first destroy equilibrium on a market must be transmitted to another market through changes in relative price and wage rates. In an economy with flexible price and wage rates as well as mobile labor forces, a one-time demand shock will launch adjustments in both the markets simultaneously and the economy may come to a new equilibrium at A^* for both the markets again. The new equilibrium price, p^*, is higher than *p*, which is a footprint of an internally accumulated shock in the immediate past. As to other macroeconomic variables, p^*w^{A*}, w^{N*}, Y^{A*} and l^* will surpass their last equilibrium levels, while Y^{N*} and profits that nonfarm firms earn fall below the last levels. Y^*, the aggregate income computed in terms of nonfarm product, will exceed Y, but merely due to the increases in *p*.

According to Equation (3.20), however, the deflated or real $Y^{*R}<Y$ because, as the result of the adjustments, more labor is employed in lower productive farm sector and less in the higher productive one. On the whole, the economy experiences an inflation and a downturn, with return migration of agricultural labor measured by $-H=-(l-l^{*})L$. According to the definition of equilibrium migration in Section IV, it is not the equilibrium one because of changes in *p*.[17]

One of the nonfarm firms' responses may be to manage to keep their workforce in production in the face of rising *p*. Firms that produce to order respond in the manner particularly because they are unable to adjust production, often unable to renegotiate on the selling prices listed in the orders as well during the period from acceptance of orders to shipment of deliveries. If the firms are not capable to enhance capital or improve techniques, they even cannot adjust labor forces they employ. After *p* rises suddenly, pw^{A} goes up. Firms have to raise w^{N} to maintain their employment, which necessarily leads to fall in profits. From the macroeconomic points of view, that the nonfarm firms are difficult in responding to increases in w^{N} implies the adjustments to the shock may take place mainly on goods market. Therefore, the extent to which *p* rises will be much bigger than that if labor market adjusts simultaneously. With bigger increases in *p*, w^{N} must go up more for employees to maintain the purchase power of their wage in term of farm product and for employers to prevent labor forces from leaving. The strong rises in *p*, pw^{A} and w^{N} will be translated into overheating in both markets: supply of farm product is short of demand on the one hand, supply of labor is short of demand on the other. Overheating of the goods market is transmitted to that of the labor market. More labor is demanded in agriculture to produce more farm products and in nonfarm sector to ease the pressure of rises in w^{N}. But there is not labor available to be employed either in agriculture or nonfarm firms. A developing country usually characteristic of redundant labor force saved in agriculture suddenly finds itself being in a dilemma of labor shortage. It seems unavoidable that some firms are forced to reduce production because of unexpected high labor costs. The production reduction by these firms may have effects predicted by the domino theory. Many firms have to follow and some even go bankrupt. A turn comes suddenly as the same as the shock begins. At one blow, labor cannot find jobs any more. Wage rates cannot go up any more. Prices begin to fall. Many migrated workers are laid off and have to go back to their original villages. A slowdown of economic activity which is needed to absorb the rise in p caused by a shock may turn to be a serious crisis, which will call the policy maker for actions.

[17] Technically speaking, migration in Figure XIV is triggered by a change in *c*, one of the parameters dealt with in section III. It is clear from Equation (3.15) and (3.18) that *p* and *l* move in the same direction of changes in *c* if capital and its allocation remain unchanged.

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Appendix

We rename Equation (3.18) to

$$\text{(A1)} \qquad \frac{l\mathrm{L}}{f^{\mathrm{A}}(\theta\mathrm{K}, l\mathrm{L})}\frac{\mathrm{d}f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]}=\gamma\frac{f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{f^{\mathrm{A}}(\theta\mathrm{K}, l\mathrm{L})}.$$

Concealing f^{A} and rearrange it to get

$$\text{(A2)} \qquad \frac{\mathrm{d}f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]}=\gamma\frac{f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{l\mathrm{L}}.$$

There is only a variable, l, in (A2) provided c, θ, K and L are assumed constants. Assuming a function G and

$$\text{(A3)} \qquad \mathrm{G}=\gamma\frac{f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{l\mathrm{L}}-\frac{\mathrm{d}f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]}.$$

If one or more values of $l^{\mathrm{E}}\in(0, 1)$ could make G=0, they must be the solutions of (A2) at the same time. Therefore, we look at (A3) now. G is continuous and differentiable at least one time since f^{N} is continuous and differentiable at least two times. Let

$\mathrm{A}=f^{\mathrm{N}}[(1-\theta)\mathrm{K}, (1-l)\mathrm{L}]$,

$\mathrm{B}=l\mathrm{L}$,

$$\mathrm{C}=\frac{\mathrm{d}f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]}.$$

When $l\to0$, that is, $(1-l)\mathrm{L}\to\mathrm{L}$, then $\mathrm{A}\to\mathrm{I}$ (I is a large finite number), $\mathrm{B}\to0$ and $\mathrm{C}\to\mathrm{J}$ (J is a small finite number), thus

$$\mathrm{G}|_{l\to0}=\gamma\frac{\mathrm{A}}{\mathrm{B}}-\mathrm{C}\to\infty.$$

When $l\to1$, that is, $(1-l)\mathrm{L}\to0$, then $\mathrm{A}\to0$, $\mathrm{B}\to\mathrm{L}$ and $\mathrm{C}\to\infty$, thus

$$\mathrm{G}|_{l\to1}=\gamma\frac{\mathrm{A}}{\mathrm{B}}-\mathrm{C}\to-\infty.$$

Summarizing both the results, it is sure that G must change from positive values to negative ones if l goes from the neighboring field of zero to that of one continuously within its definition domain of (0, 1). Therefore, there must exist some $l^{\mathrm{E}}\in(0, 1)$ that make $\mathrm{G}(l^{\mathrm{E}})=0$. At the same time, l^{E} is the solution of (A2).

For proof of uniqueness, we differentiate G with respect to l and get

$$\text{(A4)} \qquad \frac{\mathrm{dG}}{\mathrm{d}l}=\gamma\frac{1}{l\mathrm{L}}\frac{\mathrm{d}f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]}(-\mathrm{L})-\gamma f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]\frac{1}{(l\mathrm{L})^2}\mathrm{L}$$

$$-\frac{\mathrm{d}f^{\mathrm{N},2}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]^2}(\text{-L}).$$

Because

$$-\gamma\frac{1}{l}\,\frac{\mathrm{d}f_2\,[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]}<0,$$

$$-\gamma\mathrm{L}\frac{1}{(l\mathrm{L})^2}\,f^{\mathrm{N}}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]<0$$

and

$$-\frac{\mathrm{d}f^{\mathrm{N},2}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]^2}(\text{-L})=\mathrm{L}\frac{\mathrm{d}f^{\mathrm{N},2}[(1-\theta)\mathrm{K},(1-l)\mathrm{L}]}{\mathrm{d}[(1-l)\mathrm{L}]^2}<0$$

according to Inada conditions, we have $\frac{\mathrm{dG}}{\mathrm{d}l}<0$. Hence G is a monotonous function of *l*. It leads that there must be only one $l^{\mathrm{E}}\in(0,1)$ that makes $\mathrm{G}(l^{\mathrm{E}})=0$ and it is the unique solution for (A2) as well. Introducing l^{E} into the system of equations (3.1) to (3.11), we will get a set and only a set of solutions for the system as follows:

(A5) $l^{\mathrm{E}}=l^{\mathrm{E}}(c^{\sim}, \theta^{\sim}, \mathrm{K}^{\sim}, \mathrm{L}^{\sim})$,

(A6) $p^{\mathrm{E}}=p^{\mathrm{E}}(c^{\sim}, \theta^{\sim}, \mathrm{K}^{\sim}, \mathrm{L}^{\sim})$.

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